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ABSTRACT

Results are presented of a 1977 survey of 257 Papua New Guinea science teachers on: (1) teacher qualifications; (2) teaching experience; (3) science periods taught per week; (4) other subjects taught by these teachers; (5) distribution of teaching time; (6) difficulties with the new science syllabus; (7) inservice needs; and (8) improvements in new science syllabus. These results are compared with those of a similar survey taken in 1972. (SK)

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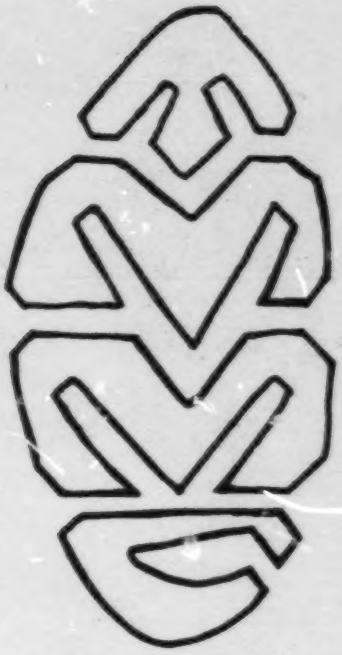
SCIENCE TEACHERS IN PAPUA NEW GUINEA HIGH SCHOOLS 1977



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I would like to express my thanks to the 257 teachers of science in Papua New Guinea High Schools who completed the questionnaire on which this report is based. Many of them spent a considerable time setting down their views and experiences in some detail and this has contributed immensely to the value of the report.

Particular thanks are also due to James Kappey of the Teaching Methods and Material Centre of the University of Papua New Guinea who devoted much time to the coding and processing of the data presented here.

Finally my thanks to Brian Deutrom and Michael Tapo of the Curriculum Unit of the Papua New Guinea Department of Education who assisted in setting up the project and in particular handled the distribution of the questionnaires.

SCIENCE TEACHERS IN PNG HIGH SCHOOLS - 1977

INTRODUCTION

During the last 20 years there has been, throughout the world, increasing emphasis on science as a component of the secondary school curriculum. In the U.S.A. there have been considerable developments in science curriculum promoted by Russia's Sputnik success and leading to developments such as PSSC (in Physics), CHEM Study (in Chemistry) and B.S.C.S. (in Biology). In the U.K. developments have been led by a number of important projects sponsored by the Nuffield Foundation. These projects have also had their influence both direct and indirect on the developing countries (1). With increasing emphasis on technical and vocational education steming from the manpower approach to educational planning these countries also have laid increasing emphasis on science education at the secondary level. But, while curriculum development is important it is increasingly becoming clear that the relationship between the curriculum and what actually goes on in schools is a crucial one (2). In particular if a new curriculum is to have any success this will only come if the schools are staffed with teachers who have appropriate qualifications, experience and attitudes to implement it and if they have the necessary materials and equipment to work with (3).

PNG has not been left out of these developments and has during the past 10 years introduced a radically new science curriculum at the primary level (TPPS) and a succession of new syllabi at the secondary level. In PNG also the teachers are a crucial factor, as an evaluation of the TPPS curriculum has shown (4). At the secondary level a survey of science teachers carried out in 1972 showed, among other things, that these teachers, while generally trained to teach science, tended to lack an adequate

science background, particularly in agriculture and most important were very limited in their teaching experience only one third having taught science in PNG for more than 3 years. In addition the survey examined the use of media and materials for science teachers (apart from laboratory materials) and showed that while the availability of these materials in schools was limited the use to which it was put was even more restricted (5).

THE SURVEY

Since the 1972 survey was carried out there has been considerable development in science education at the high school level in PNG and in particular two very significant changes. The first of these has been the rapid localisation of the high school teaching force mainly with diplomates from Goroka Teachers' College but also with graduate teachers from the Faculty of Education of the University of Papua New Guinea. (Diplomates from Goroka Teachers' College, which is part of the University of Papua New Guinea, complete a two year programme after Grade 12 while graduates of the Faculty of Education complete a four year programme after Grade 12.) The second has been the introduction, during the period, of a completely new secondary science syllabus for PNG high schools produced entirely in PNG and involving much more detailed material for teachers and a much greater extent of trialing than had been possible in the production of any previous science syllabus. A further development, so far of unknown significance, has been the introduction of "generalist" teaching in the first and some second years of the high schools. (Generalist teaching is interpreted in different ways in different schools but basically involves one teacher in teaching several (sometimes almost all) subjects to a single class.)

In view of these developments it was decided in 1977 to repeat the 1972 science teacher survey and to add to it some further material on the new science syllabus and generalist teaching. Thus in mid 1977 a trial questionnaire containing many of the original 1972 questions plus additional material was produced and distributed to

science teachers in schools in Port Moresby and surrounding areas. As a result of the feedback from these teachers, the questionnaire was modified in detail and a final version produced which consisted of 4 short sections. Section A covered teachers' qualifications in both science and education and sought teachers' views on the adequacy of these qualifications. Section B was on teaching experience and included two questions on generalist teaching. Section C asked for comments and suggestions concerning the new syllabus and the final section. Section D, was on the use and availability of media and materials for science teaching in schools. While this questionnaire was a considerably expanded version of the original, it remained reasonably compact consisting of only five A4 sides and retained some of the original questions with exactly the same wording so that direct comparisons of the 1977 and 1972 results would be possible. This report covers Section A, B and C of the questionnaire. In September 1977 the final version of the questionnaire was mailed to each of the 90 provincial high schools in PNG together with a covering letter to headmasters from the Curriculum Unit of the Department of Education describing the purpose and value of the survey and asking for co-operation. Each school received five copies of the questionnaire which were to be distributed to all teachers of science and rural science and returned to the Teaching Methods and Materials Centre of the University in a stamped addressed envelope provided. By mid November replies had been received from 257 teachers in 65 schools (72%) covering every Province in the country. It will be noted that these 257 were 'teachers of science' i.e. those who are actually doing the job of science teaching in the high schools rather than necessarily 'science teachers' i.e. those who are qualified in, or regard themselves as, or even spend most of their time in, science teaching.

RESULTS

Of the 257 teachers of science who responded 132 were nationals and 125 expatriate which corresponds with the overall high school

teaching force which, in 1977, was about 50% localized. In the analysis which follows expatriates and national teachers are frequently considered separately as they differ in many respects. It should also be borne in mind particularly when comparisons are made with the 1972 results and between national and expatriate teachers that in 1972 very few science teachers were nationals while by the mid 1980's almost all will be.

In the results which follow science includes rural science unless the two are specifically separated.

SECTION A. QUALIFICATIONS.

Section a asked about science teachers' qualifications in Education and in each of Agriculture, Biology, Chemistry, Geology and Physics which represent the disciplines included in the present science syllabus (there is also a little Astronomy). In particular the first question asked to what level each of these had been studied, with the following alternatives provided: University/ Teachers' College/High School/Other/None. The overall results for all 257 respondents are shown in Table 1. (It will be noted that not all respondents answered all parts of this question. The 'other' category in most cases (all cases for nationals) was agricultural college.)

TABLE 1

SCIENCE TEACHERS' QUALIFICATIONS.

Number and Percentage of Teachers Responding

Subject	University		Teachers' College		High School		Other		None		Total Responses
	No.	%	No.	%	No.	%	No.	%	No.	%	
Agric.	12	(5)	35	(15)	49	(21)	19	(8)	120	(51)	235
Biology	61	(26)	93	(40)	59	(25)	11	(5)	11	(5)	235
Chemistry	60	(25)	96	(40)	69	(29)	9	(4)	6	(3)	240
Geology	30	(14)	76	(35)	75	(34)	7	(3)	31	(14)	219
Physics	56	(25)	86	(39)	60	(27)	6	(3)	13	(6)	221
Education	61	(25)	158	(65)	3	(1)	4	(2)	16	(7)	242

Table I shows that most of these high school science teachers have themselves studied the science they are teaching beyond the High School level. The major exception is Agriculture which only 20% have studied beyond High School. In addition Geology has been studied beyond high school by only 49%. For the three 'major' sciences about one third have studied each only at high school or not at all. Virtually all the teachers (90%) had a teaching qualification. The major change in these figures from 1972 is a fall in the proportion with University qualifications (other than Teachers' College) in the major Sciences and Education from about 40% to 25% and a corresponding rise in the numbers with Teachers' College qualifications. This is largely due to the localisation of the teaching force as nearly all national teachers are diplomates while about half of the expatriates are graduates. The figures for national and expatriate teachers are shown separately in Tables 2 and 3 and show up these points more clearly.

TABLE 2

SCIENCE TEACHERS' QUALIFICATIONS (NATIONALS ONLY)

Number and Percentage of Teachers Responding

Subject	University		Teachers' College		High School		Other		None		Total Responses
	No.	%	No.	%	No.	%	No.	%	No.	%	
Agric.	0	(0)	30	(27)	39	(34)	9	(8)	35	(31)	113
Biology	4	(3)	76	(64)	28	(24)	7	(6)	2	(2)	117
Chemistry	5	(4)	77	(64)	32	(26)	6	(5)	1	(1)	121
Geology	2	(2)	60	(57)	35	(33)	5	(5)	3	(3)	105
Physics	8	(7)	74	(69)	17	(16)	3	(3)	5	(5)	107
Education	6	(5)	113	(93)	1	(1)	1	(1)	0	(0)	121

TABLE 3

SCIENCE TEACHERS' QUALIFICATIONS (EXPATRIATES ONLY)

Number and Percentage of Teachers Responding

Subject	University		Teachers' College		High School		Other		None		Total Responses
	No.	%	No.	%	No.	%	No.	%	No.	%	
Agric.	12.	(10)	5	(4)	10	(8)	10	(8)	85	(70)	122
Biology	57	(48)	17	(14)	31	(26)	4	(3)	9	(8)	118
Chemistry	55	(46)	19	(16)	37	(31)	3	(3)	5	(4)	119
Geology	28	(25)	16	(14)	40	(35)	2	(2)	28	(25)	114
Physics	48	(42)	12	(11)	43	(38)	3	(2)	8	(7)	114
Education	55	(40)	45	(36)	2	(2)	3	(2)	16	(13)	125

If the figures for University and Teachers' College level study are added in each of Tables 2 and 3 to give a figure for 'tertiary level study' it might appear that the national and expatriate groups are roughly equivalent in terms of their qualifications. This may well be true in terms of the Education component where the University and Teachers' College preparation in this area are likely to be equivalent. However in terms of subject matter these levels of study are not equivalent in most cases. The science course at Goroka Teachers' College at which most of the national teachers studied includes all the major science disciplines but is allocated a total of only 6 hours per week over two years and this includes work on science teaching as well as science itself. Students also undertake the study of two other subject areas (often including Maths), which are each given an equivalent weighting to that of science, as well as Education. Graduate science teachers on the other hand would normally have studied science almost exclusively for a period of three years at University. Thus the science subject background of national teachers while broad is much less deep than many of the expatriate graduates they are replacing.

Further information on qualifications was provided by a question asking about actual qualifications held. The results showed that

the 125 national teachers who responded to the question held the following qualifications:

Diploma in Teaching	106
Agriculture Certificate	10
Teaching Certificate	6
Diploma in Teaching Agriculture	5
Diploma in Educational Administration	2
Bachelor of Education	2

Holders of a Teaching Certificate have been prepared for Primary Teaching but have transferred to secondary. Neither of the two B.Ed. students had studied science - the University Science shown in Table 2 for nationals was undergraduate science courses taken at UPNG mainly in University Lahara (Summer) Sessions by diplomates. Qualifications of the 125 expatriate science teachers who responded were as follows:-

B.Sc.	56
Teachers' Certificate	32
B.A.	16
B.Ed.	11
Dip. Agric. Teaching	5
M.A.	5
M.Sc.	2
Other degrees	5
Other diplomas	7
Other certificates	3

The figures again clearly illustrate the difference in average academic level between national and expatriate teachers. In terms of the academic level of science teachers it is of some interest to compare the situation in PNG with that elsewhere. In 1973 the I.E.A. (International Association for the Evaluation of Education Achievement) published a major study of science education in 19 countries which included the qualifications of science teachers in these countries (6). Of these 19 only 2 were similar

to PNG, namely India and Iran (the rest were developed countries). Of teachers teaching science to 14 year olds, 26% were 'University trained science specialists' in India and 57% in Iran. Equivalent figures for PNG from the results obtained in this survey appear to be 0% for national teachers and 55% for expatriates (including B.Eds who may not be science specialists.)

The teachers were next asked quite specifically whether they had actually been trained to teach science. Of the national science teachers 78% had been trained to teach science while 22% had not. The 22% of the teachers of science who had not been trained for science teaching would have neither an appropriate professional nor science background, and this is a cause for some concern. Most of the national teachers who were trained in science received the training at GTC (83%) while a small number were trained in primary colleges (10%) (which indicates a preparation, for secondary science teaching, inadequate in content and inappropriate in methods) and an even smaller number overseas (2%).

Of those who were trained to teach science 63% felt that their training in methods of teaching science was adequate while only 38% felt that their preparation in science content was adequate. This is significant in terms of the discussion above of the level of academic background of national and expatriate teachers.

National teachers of science had also been trained, as pointed out above, to teach other subjects. The highest proportion were trained in Maths (43%) followed by Business and Commerce (27%), Social Science (17%), English (15%), Expressive Arts (15%), Manual Arts (12%) and smaller numbers in P.E., Health Science, all primary subjects, R.I. and Library Studies. A wide range. In view of this the teachers were also asked which was their first choice of teaching subject, 79 (62%) gave science (including rural science) as clear first choice. There were 26 of the sample who had been trained in science but did not consider science their first choice of teaching subject.

Many of these (12) had maths as their first choice, 5 social science, 3 home science, 3 manual arts and 2 English and 1 commerce. Thus, as well as the 22% of the national sample who were not trained in science and did not give science as their first choice, there were also a further 20%, approximately, who although they were trained as science teachers considered themselves first as teachers of other subjects.

Of the expatriates only 52% had been trained to teach science and they had received this training in a wide range of overseas institutions mainly in the U.K. and Australia but also in the Philippines, Canada, New Zealand and the USA. Of those who had been trained in science teaching 81% felt that their training in methods had been adequate and 90% felt that their preparation in science content was adequate. Most of the expatriates (70%) had been trained to teach other subjects and again the most frequently mentioned was Maths (44%) followed by English (18%), General Primary (16%), Religion (8%), Agriculture (8%) and Geography (8%). Seventeen other subjects were also listed. Of the expatriates 75% gave science as their first choice of teaching subject. There were only 8 of the expatriate sample who, while trained in science teaching, did not give science as their first choice of teaching subject - 7 of these gave maths and 1 English. A further complication which did not occur among the nationals was a group of expatriates who, while not trained to teach science, gave science as their first choice of teaching subject. There were 21 of the 125 expatriates who could be identified as belonging to this group of whom most (18) had degrees in science (including engineering and agriculture), 2 were primary trained and one was a (converted?) BA!

Overall then the academic level of science teachers is tending to fall as nationals replace expatriates - the main reason for this being that expatriate science teachers who are often graduates are being replaced almost entirely by national diplomates.

On the other hand while less than ¼ of national science teachers are untrained in science teaching nearly ½ of the expatriate teachers are untrained and of course the training of nationals is more directly related to the PNG High School situation. Finally many trained national science teachers express some dissatisfaction with their professional preparation while most consider their preparation in terms of science background inadequate.

SECTION B. TEACHING EXPERIENCE

Section B was concerned with teaching experience and began with questions on teachers' length of experience. Length of experience was considered overall, in relation to experience in Papua New Guinea and to science teaching and rural science teaching in Papua New Guinea.

TABLE 4

TEACHING EXPERIENCE - ALL TEACHERS.

Number and Percentage of Teacher Responding

Type of Experience	1 year	2 - 3 years	4 - 5 years	More than 5 years	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
Years of Teaching	53 (21)	72 (28)	48 (18)	84 (33)	257
Years of Teaching in PNG	59 (23)	92 (36)	46 (18)	59 (23)	256
Years of teaching science	60 (29)	67 (32)	34 (16)	47 (23)	208
Years of teaching science in PNG	66 (33)	78 (39)	38 (19)	17 (9)	199
Years of teaching R/Sc	40 (30)	45 (34)	26 (20)	21 (16)	132
Years of teaching R/Sc in PNG	34 (28)	50 (41)	20 (16	18 (15)	122

Table 4 shows the results for all teachers who responded, both

national and expatriate. Overall while about 1/5 of the teachers are in their first year of teaching and about 1/2 have no more than 3 years experience only about 1/3 have been teaching for more than 5 years. The table allows a progressive examination to be made of length of experience in teaching, in science teaching, in teaching in Papua New Guinea and in science teaching in Papua New Guinea. The fourth row of the table shows experience of the job the teachers are actually doing i.e. teaching science in Papua New Guinea - fully 1/3 of the teachers are in their first year in this job, more than 70% have been doing it for 3 years or less and less than 10% have more than 5 years experience teaching science in Papua New Guinea. The situation is very similar for rural science.

TABLE 5

TEACHING EXPERIENCE (1972 SURVEY)

Number and Percentage of Teachers' Responding

Type of Experience	1st Year		2nd./3rd. Year		4th/5th Year		More than 5th Year		Total Responses
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
Year of Teaching	9	(7)	34	(25)	24	(17)	71	(52)	138
Year of Teaching in PNG	22	(16)	59	(43)	32	(23)	25	(18)	138
Year of Teaching Science	15	(13)	38	(32)	22	(19)	44	(37)	119
Year of Teaching Science in PNG	27	(23)	55	(47)	22	(19)	13	(11)	117
Year of Teaching R/Science	18	(30)	27	(46)	7	(12)	7	(12)	59
Year of Teaching R/Science in PNG	20	(36)	27	(48)	8	(14)	1	(2)	56

A comparison of these figures for all teachers with the 1972 survey results (Table 5) which asked exactly the same questions shows the following general trends. Firstly in terms of in-

experienced teachers there are considerably more teachers in 1977 than in 1972 who are in their first year of teaching overall, of teaching in Papua New Guinea and of teaching science in Papua New Guinea. A comparison of the numbers of more experienced teachers shows a more complicated picture. In 1977 there were less teachers with 5 or more years teaching experience overall and with 5 or more years science teaching experience in Papua New Guinea and of rural science teaching experience in Papua New Guinea. Again more information can be obtained by examining the results for national and expatriate teachers separately. These results are shown in Tables 6 and 7.

TABLE 6

TEACHING EXPERIENCE (NATIONALS ONLY)

Number and Percentage of Teachers' Responding

Type of Experience	1 year	2 - 3 Years	4 - 5 Years	More than 5 Years	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
Years of Teaching	36 (27)	52 (39)	30 (23)	14 (11)	132
Years of Teaching in PNG	36 (27)	52 (39)	30 (23)	14 (11)	132
Years of Teaching Science	42 (38)	43 (38)	21 (19)	6 (5)	112
Years of Teaching Science in PNG	39 (38)	40 (40)	18 (18)	4 (4)	101
Years of Teaching R/Science	23 (30)	35 (49)	10 (14)	7 (8)	75
Years of Teaching R/Science in PNG	22 (31)	34 (47)	10 (14)	6 (8)	72

Table 6 shows that about ¼ of national science teachers are in their first year of teaching while almost 40% are in their first year of teaching science in PNG. While the bulk have between 2 and 3 years of teaching experience only about 10% have more than 5 years

teaching experience and only about 5% more than five years experience in teaching science. There is a slightly larger proportion of experienced national rural science teachers on the job - but the numbers remain very small.

TABLE 7

TEACHING EXPERIENCE (EXPATRIATES ONLY)

Number and Percentage of Teachers' Responding

Type of Experience	1 year	2 - 3 Years	4 - 5 Years	More than 5 years	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
Years of Teaching	17 (14)	20 (16)	18 (14)	70 (56)	125
Years of Teaching in PNG	23 (19)	40 (32)	16 (13)	45 (36)	124
Years of Teaching Science	18 (19)	24 (25)	13 (14)	41 (43)	96
Years of Teaching Science in PNG	27 (28)	38 (39)	20 (20)	13 (13)	98
Years of Teaching R/Science	17 (28)	10 (17)	16 (27)	17 (28)	60
Years of Teaching R/Science in PNG	12 (24)	16 (33)	10 (20)	11 (22)	49

Turning to expatriates' teaching experience, Table 7 shows that the proportion of first year teachers is much smaller than for nationals in all categories including teaching science in Papua New Guinea. At the other end of the table there are large proportions (about 1/3 to 1/2) of expatriates with more than five years overall teaching experience, experience in Papua New Guinea and science teaching experience. On the other hand the proportion of expatriate teachers with more than five years science teaching experience in Papua New Guinea is small (only 13%). Although the proportion with more than five years rural science teaching experience is larger the numbers are again small.

For both nationals and expatriates then there is a dearth of teachers with more than five years experience teaching science

in Papua New Guinea - all else being equal the most valuable science teachers in the system. If it were desired to increase the proportion of experienced science teachers in the near future it would be necessary to retain those teachers who already have some experience.

It is interesting to note from tables 6 and 7 that there are fairly large numbers of teachers with 2 - 5 years science teaching experience in Papua New Guinea among both national (58%) and expatriate (59%) teachers. However the system has not always been successful in retaining these teachers in the past.

Following the questions about length of experience teachers were asked for details of their present experience - firstly in relation to the amount of science taught. Table 8 shows the number of science periods taught each week by these teachers.

TABLE 8

SCIENCE PERIODS TAUGHT PER WEEK

Number and Percentage of Teaching Responding

Number of Periods	National		Expatriate		Total	
	No.	(%)	No.	(%)	No.	(%)
0	20	(16)	13	(11)	33	(13)
1 - 10	52	(41)	32	(27)	84	(34)
11 - 20	36	(28)	55	(14)	91	(37)
More than 20	20	(16)	18	(15)	38	(15)
Total Responses	128		118		246	

Table 8 shows a considerable spread of science teaching load with few teachers, only about 15%, having more than 20 periods (3 or 4 classes) of science each week. (Of the 20 national teachers included here who were <u>not</u> teaching science, most (13) were qualified

in rural science and are teaching only rural science or are not qualified in either science or rural science but are teaching rural science.) A further analysis of the numbers of periods taught per week in relation to qualifications of national teachers showed that those who were trained to teach science were teaching an average of 13.1 periods per week of science while those not qualified were teaching an average of only 5.1. Thus while the situation in respect of qualifications and teaching duties is far from satisfactory, schools are clearly trying to give teachers subjects for which they are qualified. At the same time the average national trained science teacher is spending under half his time, 13.1 periods out of more than 30, actually teaching science.

TABLE 9

RURAL SCIENCE PERIODS TAUGHT PER WEEK

Number and Percentage of Teachers Responding

Number of Periods	National		Expatriate		Total	
	No.	(%)	No.	(%)	No.	(%)
0	69	(54)	83	(67)	152	(61)
1 - 10	38	(30)	20	(16)	58	(33)
11 - 20	14	(11)	18	(15)	32	(13)
More than 20	7	(5)	2	(2)	9	(4)
Total Responses	128		123		251	

The large number of those teachers who teach no rural science at all (table 9) shows that for both the national and expatriate teachers the bulk of this sample are exclusively science rather than rural science teachers. Of the national teachers just 12 had a professional qualification in agriculture as well as in education. These qualified agriculturalists were teaching an average of 17 periods of rural science per week (about half a teacher's load) while the rest of the national teachers who taught rural science averaged 9 periods per week.

The question on how many periods of science were taught each week was followed up by one asking how many of these were taught in a laboratory. Overall the results showed that about 90% of science lessons were taught in a science laboratory.

The experience of these teachers included the teaching of other subjects in addition to science and rural science.

Table 10 shows the other subjects which these teachers taught Many of course taught more than one other subject. The subject most frequently taught by both national and expatriate teachers was maths as might be expected both from qualifications and subject preferences discussed above.

TABLE 10

OTHER SUBJECTS TAUGHT BY TEACHERS OF SCIENCE

Number and Percentage of Teachers Responding.

Subject Taught	National		Expatriate		Total	
	No.	(%)	No.	(%)	No.	(%)
Mathematics	44	(37)	46	(42)	100	(44)
Business Principles	33	(28)	16	(15)	49	(21)
Expressive Arts	33	(28)	12	(11)	45	(20)
Social Science	32	(27)	8	(7)	40	(17)
English	24	(20)	25	(23)	49	(21)
Manual Arts	18	(15)	13	(12)	31	(14)
Guidance	14	(12)	15	(14)	29	(13)
Home Science	9	(8)	10	(9)	19	(8)
Religious Instruction	8	(8)	23	(21)	31	(14)
Physical Education	4	(4)	2	(2)	6	(3)
Total Responses	119		110		229	

Some of the differences between national and expatriate teachers in Table 10 are of interest. The subjects which national teachers of science tend to teach to a greater extent than expatriates are

business principles, expressive arts and social science - all subjects with a strong Papua New Guinea orientation and particularly suited to national teachers. Expatriates teach only RI to a significantly greater extent than nationals - no reason for this is apparent. All in all teachers of science teach a considerable variety of subjects and spend a considerable time as Table 8 shows, teaching subjects other than science and rural science.

TABLE II

DISTRIBUTION OF TEACHING TIME %

Subjects	National	Expatriate	Total
Science	42%	42%	42%
Rural Science	16%	18%	17%
Other	42%	40%	41%

Table II shows the overall breakdown of the teaching time (periods per week) for this sample of teachers of science. The figures are very similar for national and expatriates showing that this sample of teachers of science spends about 40% of it's time teaching science, 20% teaching rural science and 40% teaching other subjects.

A significant aspect of the experience of some teachers of science in 1977 in Papua New Guinea high schools was their involvement in generalist teaching of science at Grade 7 level. The teachers were therefore asked whether science was taught in this way at their school. There was some confusion, particularly among expatriate teachers, over the question as a few clearly interpreted "generalist" as equivalent to "general science." This became clear in the comments on generalist teaching which followed. The figures given here are for those responses which clearly demonstrated that the interpretation of generalist was as was intended in the question. Of those who clearly understood the question, 34% responded that science was taught in Grade 7 as part of a generalist programme.

This must mean that despite an instruction that all schools were to offer a generalist programme in Grade 7 in 1977 many schools are either not doing so or, more likely, extracting science from this programme and having it offered by a 'specialist' teacher.

The teachers who did teach science as part of a generalist programme were then presented with an open ended question asking them to comment separately on the advantages and disadvantages of this system. Again the results of this question will be presented separately for national and expatriate teachers as their different backgrounds may well make the responses of the two groups different and it is of course the national teachers who will have to take part in generalist science teaching in the future if the system is continued.

Forty national teachers of science who had experience of generalist teaching offered their comments. They wrote rather more about the disadvantages than the advantages. (Their comments on the advantages when typed up produced 90 lines of typescript while their comments on the disadvantages produced 120 lines). The main advantage (mentioned by 14 teachers) was the opportunity to correlate the teaching of different subjects - the linking of science to maths, English and agriculture were specifically mentioned. This specific point was made more frequently than any other. The next most frequently mentioned advantage of generalist teaching (mentioned by 7 teachers) was the opportunity for non specialist science teachers to gain experience of science teaching and to learn some science themselves. The extended time spent with one class enabling the teacher to get to know his children better was seen as an advantage by 6 teachers. This was also seen (by one teacher) as being liked by pupils as it was similar to their community school experience. Other advantages mentioned by one or two national teachers were that generalist teaching produces a more flexible timetable, and enables teachers to share ideas and work together as a team.

The disadvantages of generalist teaching listed by the teachers are less easy to categorise - they were more diverse and diffuse. However most centred around the difficulties experienced by teachers untrained in science in teaching science in a generalist context. This was mentioned in one way or another by 31 of the 40 national respondents, an overwhelming response in view of the open ended nature of the question. The main difficulties identified were in relation to practical and laboratory work.

The organisation of practical work in a laboratory was seen as a specialist task, particularly in relation to dangerous experiments, specialist equipment, preparation for laboratory classes and the modification of experiments when necessary. Several teachers stated that one result of this was that non science trained teachers were afraid to do experiments and simply omitted much of the practical work set out in the syllabus. It was also stated by several teachers that teachers untrained in science experience difficulty with the content of science, ("give wrong scientific information") with scientific concepts and with scientific thinking. A different but related point was that generalist teaching by its very nature places an increased burden on teachers. It was pointed out that this not only increases the difficulties of teachers untrained in science who are faced with preparing themselves for science teaching but also means that science teachers themselves in a generalist programme find the time they can devote to science preparation restricted by a large load of preparation for subjects with which they are unfamiliar and for which they are untrained. Several national teachers claimed that the overall effect of these factors was that students' level of achievement in science in grade seven fell under a generalist structure.

Some comments by teachers recognised the theoretical advantages of generalist teaching while claiming that they were not realised in practice. For example it was stated that very little correla-

tion between subjects did take place because this requires a high level of understanding of both content and teaching methods and of the principles and practice of generalist teaching which were not available.

There were rather fewer responses to this question from expatriate teachers - only 22 - probably reflecting the tendency of schools to assign generalist teaching to national teachers. The expatriates also wrote more about the disadvantages (74 lines of typescript) than the advantages (57 lines) and many of the points made were the same as those made by national teachers.

Again the most frequently mentioned advantage (by 14 out of 22 respondents) was the possibility of integration, particularly between science, maths and English. Expatriates also mentioned greater timetable flexibility (4) and the opportunity to get to know pupils better (3). The main disadvantages of generalist teaching in relation to science seen by expatriates (mentioned by 14) was again in the area of the specialist demands of science teaching. It was noted that many generalist teachers were unenthusiastic and lacked confidence in themselves as science teachers because of their lack of knowledge of science and of science teaching techniques particularly in relation to laboratory work. It was claimed that the result of this could be 1) teaching by rote and 2) confusion among both pupils and teacher. There were also comments on wider difficulties of generalist teaching such as the lack of training and background for such teaching, the extra burden of preparation and the possibility of teacher and class becoming bored with one another.

Overall then, science is not taught as part of a generalist programme in most schools and where it is the teachers of science are aware of the theoretical advantages of the system while being concerned at the considerable difficulties of implementation.

SECTION C. THE NEW SCIENCE SYLLABUS.

The long term project through which a new, trialled and tested, science syllabus for Grade 7 to 10 of the Papua New Guinea high schools is being introduced, was virtually complete in 1977 with the distribution to all schools of the Grade 10 science units. The new syllabus (which is infact much more than a syllabus in the usual sense of an outline of content) consists of 6 units for each of the 4 years, covering a broad range of basic science, with an emphasis on relevance and applications to life in Papua New Guinea for school leavers. Each unit is presented to the teacher as a series of investigations which require pupil involvement in practical activities and considerable detailed guidance is given for teachers in teaching methods, equipment and science background. As there is a policy of continuous development of this syllabus it was decided to attempt, through the science teacher survey, to obtain feedback from science teachers which would give guidance about the strengths and weaknesses of the syllabus as seen by those teaching it in 1977. The survey therefore contained questions in general terms on materials, methods, content and timing, and asked teachers for suggestions for improvement and development.

An effort was made in the construction of the new syllabus to restrict material requirements as far as possible to easily available and inexpensive items. The first question therefore asked about the amount of difficulty experienced by teachers in obtaining the necessary materials. Teachers were required to respond by ticking the appropriate box for "much" "some" "little" or "none". Similarly structured questions asked about difficulty in using the required teaching methods, understanding the science content and completing the syllabus in the time available.

TABLE 12

DIFFICULTY WITH THE NEW SCIENCE SYLLABUS (NATIONALS ONLY)

Number and Percentage of Teachers Responding

Nature of Difficulties	Much	Some	Little	None	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
Obtaining necessary Materials	17 (16)	51 (48)	31 (29)	7 (7)	106
Using Teaching Methods Required	11 (10)	46 (42)	38 (34)	14 (13)	109
Understanding Science Content	10 (9)	36 (34)	41 (39)	18 (17)	105
Completing the Syllabus	15 (14)	38 (35)	36 (33)	20 (18)	109

Results for the national teachers (Table 12) appear to show that there is no aspect which causes more than a small minority of them much concern although obtaining material and completing the syllabus are put in this category by about 15%. However, it may well be that in a questionnaire of this type teachers would be reluctant to admit to "much" difficulty and the "some" category should be included as an indication of difficulty particularly as it is differentiated from "little" as well as "none". If therefore the "much" and "some" categories are combined a rather different picture emerges. In particular obtaining necessary materials causes at least "some" difficulty for 64% of the national teachers, using required teaching methods causes difficulties for 52%, completing the syllabus difficulty for 49% and understanding the science 45%. Although there is not much difference between these percentages it is somewhat surprising to find science content causing least difficulty in view of some of the other results of this survey. At the same time considerable efforts were made in writing the syllabus to provide background science content for teachers and perhaps this result indicates some success in this.

TABLE 13

DIFFICULTY WITH THE NEW SCIENCE SYLLABUS (EXPATRIATES ONLY)

Number and Percentage of Teachers Responding

Nature of Difficulty	Much	Some	Little	None	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
Obtaining Necessary Materials	14 (13)	44 (42)	36 (34)	11 (10)	105
Using Teaching Methods required	2 (2)	19 (18)	38 (34)	45 (43)	104
Understanding Science Content	1 (1)	9 (9)	16 (16)	77 (75)	103
Completing the Syllabus	12 (12)	23 (22)	33 (32)	36 (35)	104

The expatriate results provide some interesting comparisions (table 13). Again considering the "much and "some" categories, about 60% of expatriates also have difficulty in obtaining materials - confirming the existence of widespread problems in this area. About 1/3 of expatriates also have some difficulty in completing the syllabus in common with 1/2 of the national teachers. However, allowance here should be made for the fact that teachers would be teaching much of this syllabus for the first time and with a little more time and experience it could well be that materials shortages would be overcome and the work required completed more quickly. Other responses show that there are large differences between expatriate and national teachers expressed level of difficulty with both teaching methods and science content. Expatriates perceive much less difficulty with both these areas. Difficulty with science content can be clearly related to past level of study of science. Here as Table 2 and 3 above showed, expatriates have generally higher qualifications and hence have less difficulty. Similarly Tables 6 and 7 show that expatriates generally have longer experience in science teaching both in Papua New Guinea and elsewhere which no doubt assists them in overcoming teaching problems in the new syllabus. On the other

hand more national teachers are trained in science teaching and of course specifically for the Papua New Guinea situation, although it is only recently that Papua New Guinea teachers have been prepared for the new science syllabus. In an attempt to examine this further a check was made on the reported level of difficulty with teaching methods and science content of untrained national science teachers compared with trained national teachers. This appeared to show that the untrained teachers had more difficulty with content but less with teaching methods. However, the number involved and differences found were too small for any significant difference to be established. It was anticipated that some teachers might be reluctant to admit to difficulties in relation to the new syllabus so a further question asking about desired in service courses was included. Teachers were asked to say what type of inservice course they thought would be most useful to them. Types of courses listed were "course on science", "course on teaching methods", and "course on specific unit" and teachers were asked to indicate whether they considered each of these "essential", "needed", "useful" or "not needed". It was hoped that this would give some further insight into teachers perceived difficulties. Responses to this questions are shown in Tables 14 and 15.

TABLE 14

INSERVICE NEEDS (NATIONALS ONLY)

Number and Percentage of Teachers Responding

Type of Course	Essential		Needed		Useful		Not Needed		Total Responses
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
Science Content	55	(50)	24	(22)	27	(24)	5	(5)	111
Teaching Methods	30	(28)	36	(34)	29	(27)	12	(11)	107
Specific Unit	40	(38)	30	(29)	29	(28)	5	(5)	104

Table 14 shows that national teachers of science felt a considerable

need for courses related to their work - in particular 50% felt that a course in science content was essential. If the first two columns of the table are combined it appears that 72% think that a course in science is "essential" or "needed" while 62% feel the same about courses in teaching methods. Finally 67% feel a strong need for courses on specific units. Asked to specify on which unit courses should be provided the following were given by the numbers of teachers shown in brackets:- Electricity (18), Biology (14), Chemistry (12), Geology (9), Force, work, energy (9), Chemical technology (8), Microbiology (8), Physics (7), Ecology (7), Growth and reproduction (7), and 13 other units each by 5 or less teachers. This represents a considerable range of units causing difficulties. It may be that electricity and biology are frequently mentioned because the syllabus contains a considerable amount of material in these areas, but this does not apply to Chemistry and Geology which are much less extensively treated.

TABLE 15

INSERVICE NEEDS (EXPATRIATES ONLY)

Number and Percentage of Teachers Responding

Type of Course	Essential		Needed		Useful		Not Needed		Total Responses
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
Science Content	2	(2)	11	(11)	24	(24)	54	(55)	99
Teaching Methods	3	(3)	16	(17)	31	(32)	46	(48)	96
Specific Unit	2	(2)	18	(18)	40	(40)	41	(41)	101

The figures for expatriate course needs in Table 15 again show a marked contrast to those for national teachers. Expatriates felt a much lesser need for inservice courses. Expatriates listed the following units for courses on specific units:- Traditional technology (8), Electricity (8), Microbiology (6), Energy, work and force (6), and 12 other units each listed by 5 or less teachers. Traditional technology is of course a unit for which expatriates'

background and experience are likely to provide little of relevance.

Finally teachers were asked what improvements they thought were most needed in the new science syllabus - first in a multiple choice question and secondly in an open-ended question. The multiple choice question listed "more background science for teachers", "more detailed teaching methods", "more details of pupil activities", "more worksheets", "more freedom for the teacher to make his own curriculum" and "better supply of equipment" and asked for responses chosen from "essential", "needed" "useful" "not needed". The results are shown in Table 16 and 17.

TABLE 16

IMPROVEMENTS IN NEW SCIENCE SYLLABUS (NATIONALS ONLY)

Number and Percentage of Teachers Responding

Suggested Improvement	Essential		Needed		Useful		Not Needed		Total Responses
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
More Background Science	70	(62)	27	(24)	10	(9)	6	(5)	113
More detailed Methods	26	(23)	32	(28)	41	(36)	16	(14)	115
More detailed Activities	34	(30)	27	(23)	42	(37)	12	(10)	115
More Worksheets	24	(21)	32	(28)	40	(35)	18	(16)	114
More Teacher Freedom	17	(16)	24	(22)	40	(37)	26	(24)	107
Better Equipment Supply	73	(64)	20	(18)	16	(14)	5	(4)	114

Table 16 shows clearly that the areas in which national teachers would like to see the new science syllabus developed are those of more science background for teachers and better equipment

supply. On the other hand they are much less concerned about more freedom for the teacher to make his own curriculum. These findings complement those from other parts of the survey. The syllabus committee has recently been persuing a policy of providing more worksheets for teachers as these provide considerable help for the inexperienced teacher. However although this is certainly not rejected by these teachers it does not seem particularly popular perhaps because along with their undoubted advantages worksheets do demand a good supply of equipment and a considerable amount of teachers' time in the preparation of equipment.

TABLE 17

IMPROVEMENTS IN NEW SCIENCE SYLLABUS (EXPATRIATES ONLY)

Number and Percentage of Teachers Responding

Suggested Improvement	Essential	Needed	Useful	Not Needed	Total Responses
	No. (%)	No. (%)	No. (%)	No. (%)	
More Background Science	28 (28)	20 (20)	37 (37)	14 (14)	99
More Detailed Methods	8 (8(	16 (16)	36 (36)	40 (40)	100
More Detailed Activities	7 (7)	21 (21)	39 (39)	32 (32)	99
More Worksheets	11 (11)	22 (21)	30 (29)	41 (39)	104
More Teacher Freedom	8 (8)	16 (17)	36 (38)	35 (37)	95
Better Equipment Supply	28 (31)	25 (27)	38 (42)	10 (11)	91

The expatriate results in Table 17 show a very similar pattern to those from the national teachers except that the need for improvement is judged to be much less urgent.

The final question in Section C asked for written suggestions which would "help improve science teaching in Papua New Guinea High Schools". This elicited a considerable response in terms of both numbers of responses and the content of each. Of the 132

Papua New Guinea teachers 115 wrote in suggestions, some of them of considerable length. Some took the opportunity to re-emphasise points which had been covered in other parts of the questionnaire, others introduced new areas of concern. Responses provided by teachers to this question should be given considerable weight as (a) the issues raised were chosen by the teachers themselves, (b) teachers spent considerable time and energy in constructing their responses in contrast to much of the rest of the questionnaire which required only a choice from alternatives provided.

In fact the specific issue which was raised by the largest number of individual national teachers was one which had not been covered in the questionnaire.

This was the question of the provision of text books in science for student use. While one teacher wrote that pupils should not be provided with a text book as this would encourage the teacher to fall back on reading and try to cover too many topics, there were 17 national teachers of science who asked specifically that a text should be provided. A variety of reasons were given for this including the necessity of pupils "reading around" a topic and providing themselves with more background knowledge, as well as assisting the teacher in providing homework assignments and test examples. In related areas of the provision of print materials for the syllabus there were 9 requests for more science background information for teachers and 5 for more guidance on laboratory matters - safety, cleaning apparatus etc. Other suggestions made by several national teachers included more materials for generalist teachers, more background notes for pupils, the extension of the provision of pupil readers and the desirability of master stencils for worksheets being provided for schools to save time and improve the quality of these sheets. There was also some concern expressed over the provision of suitable non-print materials including charts and filmstrips.

However there was greater concern with the shortage of laboratory materials and equipment which was causing difficulties in following the activity oriented methods of the new syllabus. It was suggested that in service work be organised on the construction of simple materials and that a handbook for teachers on this subject be provided. The most popular suggestion in relation to laboratory equipment (from 11 teachers) was that there should be a system set up at headquarters which would co-ordinate the ordering and supply of such materials. It was hoped that this would enable teachers to obtain needed materials both more cheaply and more quickly.

Apart from the provision of various types of materials the other main area which provoked a large number of responses was that of the teachers themselves and in particular preparation for science teaching.

The most frequently mentioned concern here was that science should be taught by trained, specialist teachers and not by generalists (mentioned by 14). There was also an insistent demand for more in-service training. Often it was specifically suggested that this should be in science content and at UPNG, but there were also suggestions for more in-service in schools themselves (including sessions conducted by visiting members of the syllabus committee) and through subject meetings. There were also some suggestions from 5 teachers relating to pre-service training. All of these implied that present preparation was inadequate and suggestions included the raising of the entry requirements for potential science students at G.T.C. and the lengthening of the course by one year. There was also concern expressed by some teachers at the teaching load science teachers were expected to carry and in particular the number of different subjects for which teachers found themselves preparing material.

Although the new science syllabus itself was mentioned by slightly fewer teachers than the problems related to materials and teachers mentioned above, it did provide the greatest number of different suggestions. The most popular, (mentioned by 15) was that the syllabus should be made more relevant to students' immediate environment in various ways. One way which was suggested by 8 teachers was that it should start from or relate to traditional knowledge. Other ways included relevance to agriculture and the school leaver and emphasis on actual applications of science to the appropriate urban or rural environment. There were also a large number of other specific suggestions-among these made by more than one teacher were the need for modification of the syllabus for remote, underequipped schools, the need for a glossary of scientific terms (already provided in some units), the desirability of more practical lessons outside the classroom and a greater emphasis on student research projects.

There were, as might be expected, some issues on which a divergence of views was apparent. For example a small number of teachers thought the present syllabus was too difficult while an even smaller number thought it was over simplified. Similarly some teachers felt there was too much emphasis on facts and others that the syllabus was too abstract and concept oriented (the concept of particles was specifically mentioned by a couple of teachers in this regard).

Finally, there were some suggestions which fell outside any of the above categories. These included the provision and training of laboratory assistants, the formation of a science teachers' association and the introduction of team teaching so that science teachers of different backgrounds, qualifications and experience could learn from each other.

Of the 125 expatriates only 54 produced responses to this last open ended question. This may be because many, especially those of limited experience, felt that it was not appropriate for them to comment on how science teaching could be improved in Papua New Guinea. In fact most of those who did respond specifically related their comments to the needs of national teachers and many of the suggestions made, perhaps partly for this reason, were the same as those made by national teachers. For example, widely proposed by expatriate teachers (10) in relation to materials was the provision of a text book specially written for Papua New Guinea pupils. There was also the need expressed for more laboratory equipment (7) and again the need for a better organised supply for schools especially in view of national teachers' lack of expertise and experience in ordering materials. A need was seen for visual materials, especially slides, prepared specifically for Papua New Guinea and the use of radio broadcasts and material from the national press was also suggested.

In terms of the teachers, expatriates confined their comments almost exclusively to the needs of national teachers and in this area there was considerable disquiet expressed. Firstly it was stated (by 10 teachers) that for all national teachers there was a considerable need of in-service work particularly in terms of science background where it was felt by some that fairly extended university level courses were needed. In addition specific weaknesses in the area of student assessment were mentioned by 3 teachers. It was also felt that all teachers should have an initial training in science before beginning to teach science and examples were quoted of (a) GTC diplomates who had no training in science and experienced considerable difficulties, especially in the laboratory and (b) primary trained teachers who were "at a complete loss". Some expatriates also stated that those who had been trained at GTC for science had an insufficient grasp of science and of laboratory proceedures.

In relation to the syllabus the expatriate teachers, like their national colleagues, made a considerable number of specific suggestions. Again most of these related to relevance in the Papua New Guinea context - to rural and urban life, to agriculture, to traditional knowledge and to local flora and fauna. While most thought this was the right orientation and that there should be more of it two or three thought that the attempt to make the syllabus more relevant had led to a disjointed approach in which the applications could not be understood because the basic science had not been studied (this critisism was made by 2 teachers specifically in relation to the lack of basic chemistry for biological and chemical technology units). Other suggestions included the need for more flexibility in the syllabus to cope with varying circumstances often relating to lack of materials, the greater use of mathematics in science, the importance of project work, the need for links with other curriculum areas, the need for more help for new science teachers and the need to be aware of student levels of concept development.

In very general terms then both national and expatriate teachers see an improvement in science teaching and learning coming from better prepared teachers combined with a more adequate supply of materials. While there are a multitude of opinions on the curriculum there seems to be general agreement with the style and content of the new syllabus.

SUMMARY AND CONCLUSIONS

The comparisons drawn in this paper, between teachers of science in Papua New Guinea high schools in 1972 and in 1977 and between expatriate and national teachers of science in 1977, in many ways run parallel. The reason for this is simply that the dominant trend between 1972 and 1977 has been the rapid replacement of expatriate teachers by national teachers. The results of the survey described here show that national teachers of science (and

teachers of science in 1977) when compared with expatriate teachers of science (and teachers of science in 1972) displayed the following broad differences. The national teachers tended to be less well prepared academically (in science content) and to have less teaching experience - even when teaching experience outside Papua New Guinea is discounted. On the other hand more of them were trained to teach science and their training, unlike that of expatriates, was specifically related to PNG needs.both in terms of breadth of content and relevance to the PNG environment and classroom.

In view of these broad differences it is interesting to look at differences which emerge from other parts of the survey. Firstly many more national than expatriate science teachers felt that their teacher preparation had been inadequate for the job they were doing in schools. In particular many national teachers felt that their science background was inadequate and that in-servide work in this area was much needed. In relation to the new science syllabus many more national than expatriate teachers stated that they found themselves in difficulty with both content and methods and asked for various kinds of assistance including text books, back up materials and in-service courses. It appears that more national teachers are involved in generalist teaching (although only a minority of schools appear to use this approach in science) and this causes a considerably increased burden and difficulties for these teachers.

In terms of the burden placed on teachers a factor which emerges from the survey is the broad range of subjects which teachers were required to teach. Thus even qualified national science teachers devoted, on average, only about 13 periods per week to science teaching (The very few well qualified national rural science teachers were similarly underutilised). This raises the question of whether there is a shortage of science teachers in

Papua New Guinea as is often stated. Although there are numbers of teachers untrained in science actually teaching science in PNG high schools it would appear that any specific shortage is due not to an overall lack of qualified teachers of science but rather to difficulties in allocating trained trachers to appropriate timetables within schools or to difficulties in posting appropriately qualified teachers to particular schools where they are needed in the first place.

There is some cause for concern relating to the level of qualifications and experience of teachers who were teaching science in PNG High Schools in 1977. For the future a rapidly increasing output of diplomates from Goroka Teachers' College means that an accelerated replacement of relatively well qualified and experienced expatriates by less well qualified and experienced national teachers is inevitable. Desirable though the replacement of expatriates by nationals is in many ways, not least financially and politically, but also educationally, this paper shows that it is likely to cause some difficulties, certainly if national teachers' perceived level of difficulty with the new science syllabus in fact represents the real situation. Among ways of alleviating this situation would be to provide a more extensive preparation, particularly in science content, to diploma teachers during their pre-service preparation. Another would be to provide more in-service opportunities for these teachers and a third, as mentioned above, would be to create incentives for those teachers, both national and expatriate, with some science teaching experience already to remain in the classroom. Finally there is considerable evidence from this survey that many teachers consider that the use of teachers untrained in science to teach science classes is highly counterproductive and that even trained teachers require more help than they are now getting particularly in terms of teaching and background materials.

A crucial finding of this survey remains unexplained. Expatriates who are more than half graduates are being replaced entirely by national diploma teachers - not a single national science or education graduate was found in this survey teaching science (there probably are none). This was of course never intended. The University of Papua New Guinea had by the time of this survey (late 1977) produced almost 80 national Education graduates but of these only about 10 were at that time engaged in classroom teaching (7) and none of these were in science education. While there are many attractive opportunities for all eudcation graduates outside the classroom the position is particularly difficult in science education as the number of students passing through the Science Faculty (from which potential science education graduates are recruited) has been small and counter attractions for these students are numerous and pressing. However, a streaming system within the University which began to operate in 1977 should go some way to ease this situation and bring a more realistic balance to the University's graduate output.

Finally a further source of well qualified national science teachers is the recently introduced in-service B.Ed. programme of the University of Papua New Guinea. This, in essence, provides experienced diplomates of Goroka Teachers' College with a two year full time programme which, for science teachers, consists largely though not entirely of science content, and leads to a B.Ed. This programme could do much to answer the expressed needs of national science teachers in Papua New Guinea as they have emerged from the survey described in this paper. But these national graduates are needed quickly and in large numbers to replace the well qualified and experienced expatriate teachers of science who are rapidly leaving the Papua New Guinea education system.

REFERENCES

1. Lockard, J. David (Ed.) Science and Mathematics Curricular Developments Internationally 1956-74. The Ninth Report of the International Clearinghouse on Science and Mathematics Curricular Developments. The Science Teaching Centre. University of Maryland, 1975.

2. Eggleston, J.F., Galton, M. and Jones, M.E. Processes and Products of Science Teaching. London. Macmillan/Schools Council 1976.

3. Harding, J.M., Kelly, J.P. and Nicodemus, R.B. The Study of Curriculum Change, Studies in Science Education. Vol 3. 1976.

4. Wilson, Michael Three Phase Primary Science: Has it Worked? PNG Journal of Education Vol 10 No.2 October 1974.

   Wilson, Michael Three Phase Primary Science. Phase Three Evaluation Interim Report. TMMC Research Report 24. University of Papua New Guinea, March 1974.

5. Wilson, Michael and Wilson, Audrey. Science Teachers and Materials in PNG High Schools. TMMC Research Report 21. University of Papua New Guinea. June 1973.

6. Comber, L.C. and Keeves, J.P. Science Education in 19 Countries - an empirical study. Srockholm, Almquist and Wiksill. New York, John Wiley 1973.

7. Wilson, Michael Demand and Supply of B.Ed's. Paper presented at the Extraordinary Meeting 1977, Faculty of Education, University of Papua New Guinea. 22nd-23rd. Sept. 1977.